Active Project (2016 - 2018)

Fault Management Technologies - Metrics Evaluation and V&V, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Functional robustness, resulting from superior engineering design, along with appropriate and timely mitigating actions, is a key enabler for satisfying complex mission goals, and for enhancing mission success probability. Fault Management (FM) is a crucial mechanism to ensure system functionality from system design through the operational phase of a mission. FM is implemented with spacecraft hardware, on-board autonomous software that controls hardware, software and information redundancy, ground-based software and procedures. Given that most NASA missions require highly complex systems, at least a basic level of fault detection and isolation capability is almost always added on to them to protect against thousands of potential failure modes. It is therefore imperative to treat FM like any other engineering discipline and formalize the tools, metrics and best practices to ensure a uniformly high quality of implementation of FM across all NASA missions. The proposal to utilize recent advances in the theory and practice of FM, and in particular in the theory and practice of FM metrics, to enhance the ability of system and FM engineers and operators to measure and document the value, cost and risks associated with the FM design. This SBIR is aims to utilize existing capabilities of TEAMS toolset and extending it as necessary to enable it to compute a range of FM metrics, quantitative assessment of an FM design and V&V of the FM activities. As schedule and resource pressures build, there comes a need to reduce the amount of planned testing while guaranteeing a degree of confidence in FM design. By defining a methodical approach to identifying and assigning priorities to tests, one can define a minimum set of tests required to certify FM (i.e., incompressible test list). This SBIR also seeks to develop a Prioritized Validation Test Suite that ensures that critical risks are detected and appropriate FM Mitigation Strategies are employed to minimize the risk.

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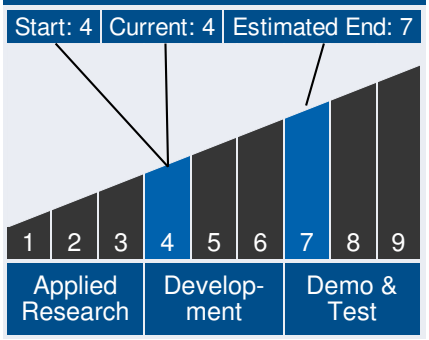
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

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ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: NASA's system design and engineering community, especially those who are involved with Systems Health and Fault Management (FM) have a vision of ensuring that FM design is an established rigorous discipline with consistent processes and methodologies that can be applied across all NASA platforms. The proposed effort has significant range of applications across various NASA multi-disciplinary engineering centers that are in charge of System Design where FM is an integral part of the System Design process. Quantifying SHM/FM in terms of standard and recognized metrics has been proven in practice in the Space Launch System (SLS), managed by Marshall Space Flight Center. The metrics developed here for TEAMS are perfectly general to any system that uses FM. The QSI team has close relationship with the NASA MSFC SHM team responsible for the design of the FM system who are also current users of the TEAMS software. Likewise, other immediate applications of this technology will be with the Orion Multi-purpose Crew Vehicle (MPCV) Program, managed by Johnson Space Center, and the Ground Systems Development and Operations Program, the operations and launch facilities at NASA's Kennedy Space Center in Cape Canaveral, Florida. Other strong users of TEAMS, with strong FM programs include Glenn Research Center, Ames Research Center, and Jet Propulsion Laboratory. The aviation programs at ARC and at Langley Research Center are also likely long-term beneficiaries of this project.

To the commercial space industry:

Potential Non-NASA Commercial Applications: DoD institutions such as the Missile Defense Agency, Air Force and Navy that use SHM and FM in many applications can benefit from the metrics implemented in TEAMS. Applications that can benefit include aircraft, spacecraft, launch vehicles, ships, submarines, and command and control systems. FM performance metrics will

Management Team *(cont.)*

Principal Investigator:

- Sudipto Ghoshal

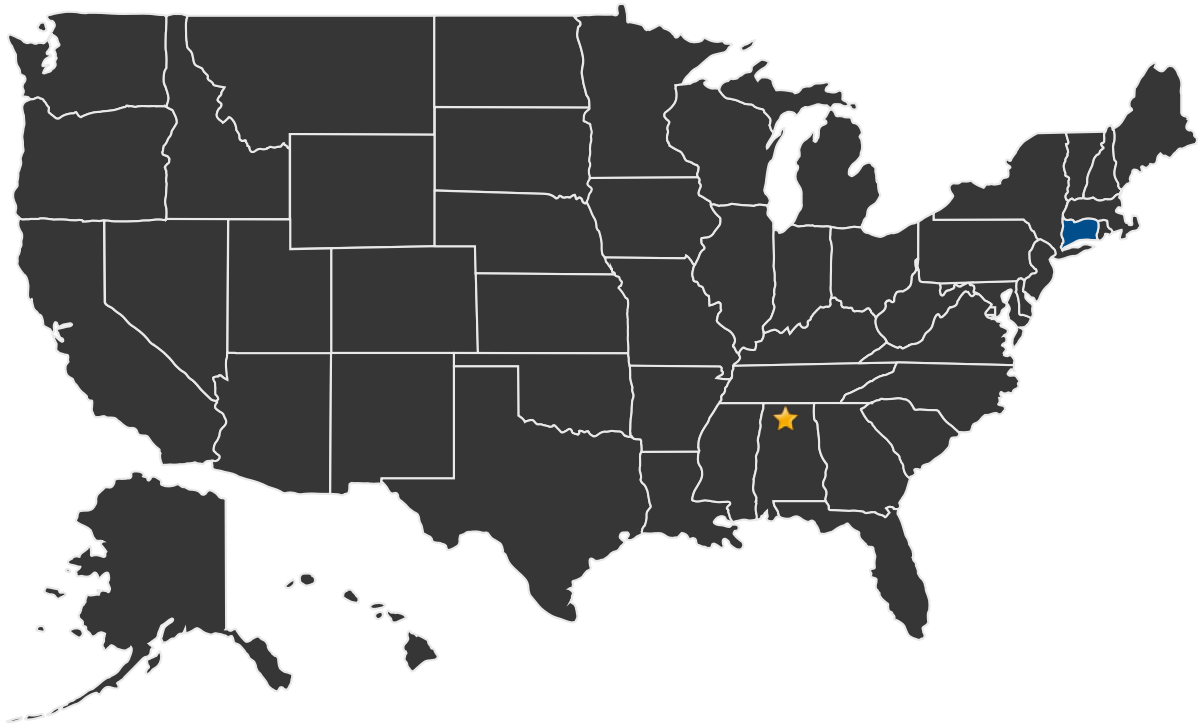
Technology Areas

Primary Technology Area:
Modeling, Simulation, Information Technology and Processing (TA 11)

- Information Processing (TA 11.4)
  - Science, Engineering, and Mission Data Lifecycle (TA 11.4.1)

help determine the efficacy as well as identify the gaps for FM on the TEAMS based CBM+ solution being developed onboard the LCS by QSI along with Lockheed Martin (LM), General Dynamics and NAVSEA. In addition, UAVs, UMGs and other unmanned submersible vehicle markets where the FM aspects of system design is required to be highly efficient and cost-effective because of the natural budgetary pressures, could also be potential targets for the proposed technology. QSI is working with LM on leveraging TEAMS technology for FM for actuation processes with the KMAX unmanned helicopters with potential application to other LM unmanned aerospace and marine vehicles. Technology developed through this effort will also be critical to measure the current performance of those FM systems as well as identify potential deficiencies under different failure scenarios. Outside of the DoD, electrical power and nuclear power utilities also require rigorous modeling techniques such as those developed here. The automotive industry is also now adopting more formal methods than in the past, largely drawn from aerospace applications but adapted to the automotive context.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Other Organizations Performing Work:

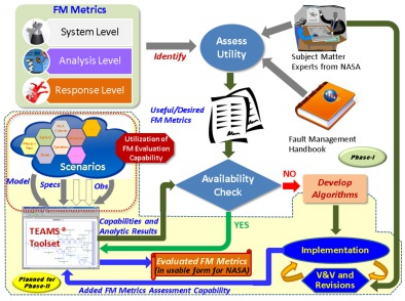
- Qualtech Systems, Inc. (East Hartford, CT)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23438)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

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Potential Applications

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